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FIRE DETECTOR

~~Background Information~~FIELD OF THE INVENTION

The present invention relates to a fire detector~~according to the definition of the species in Claim 1 and an operating method for a fire detector of this type according to the definition of the species in Claim 11.~~.

BACKGROUND INFORMATION

An optical fire detector, including a radiation transmitter and a radiation receiver, which manages without an optical labyrinth and may thus be installed flush in a ceiling, is ~~known from~~described in German Patent Application No. DE 199 12 911 C2. Furthermore, the fire detector includes a system, using which soiling of the transparent cover plate of the fire detector may be recognized and, in addition, it may be monitored whether the radiation transmitter and radiation receiver of the fire detector provided for recognizing smoke still operate correctly. The ~~known~~conventional fire detector has the disadvantage that in addition to the radiation transmitter and radiation receiver provided for recognizing smoke, further radiation transmitters and radiation receivers are necessary for recognizing soiling and for function checking. Overall, at least three radiation transmitters and three radiation receivers are thus necessary.

A fire detector having a system, using which it is possible to differentiate between smoke and other foreign bodies in the scattering volume, is ~~known from~~described in German Patent Application No. DE 100 46 992 C1. A significant complexity is also necessary in this known fire detector for differentiating between

smoke and other foreign bodies, which makes manufacturing of a fire detector of this type more expensive.

~~Advantages of the Invention~~

SUMMARY

The present invention ~~discloses~~relates to a fire detector which includes manifold functions and is distinguished by particularly high operational reliability in spite of a reduced complexity. The objects described in both of the publications cited with regard to the related art ~~are~~may be achieved simultaneously using only three radiation transmitters and three radiation receivers in this case. Because at least one of multiple scattering volumes includes at least a partial area of a cover plate that terminates the fire detector, soiling of the cover plate may be recognized reliably. Through selective controllability of the radiation transmitters and radiation receivers using a microcomputer, the reliability performance of the radiation transmitters and radiation receivers of the fire detector may be checked easily. Furthermore, it is possible to differentiate between smoke and objects in front of the fire detector. By analyzing the scattered radiation measured values of scattering volumes which have different distances from the cover plate, the fire detector designed according to the present invention may differentiate various types of smoke from one another and therefore also better differentiate between signals originating from smoke and interference. Through comparison of scattered light measured values obtained at different instants, changes in the ambient temperature or aging effects may be recognized reliably and compensated for using appropriate correction factors. Finally, the ~~disclosed~~ fire detector also displays an even lower sensitivity to interfering radiation.

~~Drawing~~

BRIEF DESCRIPTION OF THE DRAWINGS

~~Exemplary~~Example embodiments of the present invention ~~will be~~are described in greater detail ~~in the following~~below with reference to the ~~drawing~~figures.

Figure 1 shows the schematic construction of a fire detector according to the scattered light principle~~,~~.

Figure 2 shows the construction of a fire detector according to an example embodiment of the present invention~~,~~.

Figure 3 shows a block diagram of a fire detector according to an example embodiment of the present invention~~,~~.

Figure 4 shows a fire detector subject to interference from interfering radiation~~,~~.

Figure 5 shows the scattered radiation measurement in a fire detector according to an example embodiment of the present invention~~,~~.

Figure 6 shows the function monitoring of a radiation transmitter and a radiation receiver in a fire detector according to an example embodiment of the present invention~~,~~.

Figure 7 shows the holder for radiation transmitters and radiation receivers in a fire detector according to an example embodiment of the present invention.

~~Detailed Description of the Exemplary Embodiments~~

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

Figure 1 shows the schematic construction of a ceiling-flush fire detector 1 according to the scattered radiation principle. Fire detector 1 includes a housing 3, which is positioned ceiling-flush in a corresponding recess of ceiling 2 of a room. The housing is covered by a cover plate 4. A radiation transmitter 5 and a radiation receiver 6 are situated in housing 3 in such a way that no radiation may reach radiation receiver 6 directly from radiation transmitter 5. Rather, they are situated in such a way that their beam paths 50, 60 intersect outside cover plate 4. This intersection area is referred to as scattering volume 7. If scattering particles enter this scattering volume 7 from smoke generated by a fire source, for example, then the radiation emitted by radiation transmitter 5 is scattered on the smoke. A part of the scattered radiation thus reaches radiation receiver 6. The quantity of scattered radiation which is scattered by smoke particles to radiation receiver 6 at a given brightness of radiation transmitter 5 is a function of the composition of the smoke (the particle size in particular), the color of the smoke, the wavelength of the radiation used, and the scattering angle. The scattering angle is understood as the angle between the optical axis of radiation transmitter 5 and the optical axis of radiation receiver 6. Radiation transmitter 5 is controlled by a microcomputer 9. Radiation receiver 6 is connected to an electronic circuit system 8, which ~~essentially~~ includes ~~amplification means and filtering means~~an amplifier and a filter. The amplified scattered radiation signal may be input and analyzed by microcomputer 9 via an A/D converter (not shown here). If the scattered radiation signal exceeds a specific predefinable threshold, fire detector 1 triggers an alarm. This alarm is expediently relayed via a bus system to a fire alarm center, from which the fire department is then notified, for example.

A first ~~exemplary~~example embodiment of a fire detector 1 according to the present invention is shown in Figure 2. Fire detector 1

includes three radiation transmitters 5.1, 5.2, 5.3 and three radiation receivers 6.1, 6.2, 6.3.

Radiation transmitters 5.1, 5.2, 5.3 and radiation receivers 6.1, 6.2, 6.3 are situated in this case in such a way that their beam paths result in three different scattering volumes 7.1, 7.2, 7.3. First scattering volume 7.1 is formed by the beam paths of radiation transmitter 5.1 and radiation receiver 6.1. Second scattering volume 7.2 is formed by the beam paths of radiation transmitter 5.2 and radiation receiver 6.2. Third scattering volume 7.3 is formed by the beam paths of radiation transmitter 5.3 and radiation receiver 6.3. Radiation transmitter 5.1 and radiation receiver 6.1 are oriented in such a way that scattering volume 7.1, in which this system responds sensitively to smoke particles, is located several centimeters below cover plate 4 of fire detector 1, which is transparent to infrared light. Scattering volume 7.2 formed by the beam paths of radiation transmitter 5.2 and radiation receiver 6.2 may also be situated at a distance of several centimeters from cover plate 4. Alternatively, radiation transmitter 5.2 and radiation receiver 6.2 may also be oriented in such a way that scattering volume 7.2 has a larger or smaller distance from cover plate 4, however. Scattering volumes 7.1 and 7.2 are situated in this case in such a way that they do not overlap, but rather preferably are at a distance of several centimeters. Furthermore, radiation transmitter 5.2 and radiation receiver 6.2 are situated rotated by 180° in relation to radiation transmitter 5.1 and radiation receiver 6.1.

In addition, radiation transmitter 5.3 and radiation receiver 6.3 are oriented in such a way that scattering volume 7.3 formed by their beam paths includes at least a partial area of the surface of cover plate 4.

A block diagram of fire detector 1 shown in Figure 2 is illustrated in Figure 3. Radiation transmitters 5.1, 5.2, 5.3 are connected to a microcomputer 9 which controls the radiation transmitters. Radiation receivers 6.1, 6.2, 6.3 are connected to ~~a switching means~~switch 11 having multiple switch elements 11.1, 11.2, 11.3. In this case, the input terminal of each switch element 11.1, 11.2, 11.3 is connected to the associated radiation receiver 6.1, 6.2, 6.3. The output terminals of switch elements 11.1, 11.2, 11.3, which are connected to one another, are connected to the input terminal of an electronic circuit system 8. This circuit system includes ~~filtering means and amplification means~~a filter and an amplifier. The output terminal of electronic circuit system 8 is connected to the input terminal of microcomputer 9. Furthermore, ~~switching means~~a switch 11 is connected to microcomputer 9, which controls ~~switching means~~the switch 11.

Radiation transmitters 5.1, 5.2, 5.3 are controllable individually by microcomputer 9. Since ~~switching means~~switch 11 is also controllable by microcomputer 9, radiation transmitters 5.1, 5.2, 5.3 and radiation receivers 6.1, 6.2, 6.3 may be activated in any arbitrary predefinable combinations to jointly form scattering volumes.

The mode of operation of fire detector 1 according to the present invention is described below.

The following functions may be implemented as a function of which radiation transmitters 5.1, 5.2, 5.3 are controlled by microcomputer 9 and of which radiation receivers 6.1, 6.2, 6.3 are connected by ~~switching means~~switch 11 to electronic circuit system 8 at the instant at which radiation transmitters 5.1, 5.2, 5.3 emit radiation.

It is assumed that radiation is emitted by radiation transmitter 5.1 and received by radiation receiver 6.1 or radiation is emitted by radiation transmitter 5.2 and received by radiation receiver 6.2. In this case, the smoke density may be measured in scattering volume 7.1 and/or in scattering volume 7.2, which are located at a distance of several centimeters from the surface of cover plate 4. In the measurement using radiation transmitter 5.1 and radiation receiver 6.1, i.e., using scattering volume 7.1, a scattered radiation measured value S11 is obtained. In the measurement using radiation transmitter 5.2 and radiation receiver 6.2, i.e., using scattering volume 7.2, a scattered radiation measured value S22 is obtained. By comparing scattered radiation measured values S11 and S22, one may advantageously differentiate whether an interfering object, such as an insect 10 (Figure 2), or smoke is located in front of fire detector 1. If an insect 10 is located in scattering volume 7.1 (Figure 2), for example, scattered radiation measured value S11 is much larger than scattered radiation measured value S22, since a large amount of radiation is reflected on insect 10 located in scattering volume 7.1. In contrast, in the event of a fire, it may be assumed that smoke produced by the fire is distributed ~~essentially~~generally homogeneously in the comparatively small area in front of cover plate 4 of fire detector 1. However, this would have the result that scattered radiation measured value S11 would be approximately equally as large as scattered radiation measured value S22. In a first embodiment variation of the present invention, scattered radiation measured values S11, S22 are obtained essentially simultaneously. This is made possible by activating two scattered volumes 7.1 and 7.2 simultaneously. In turn, this is achieved in that radiation transmitters 5.1 and 5.2 and radiation receivers 6.1, 6.2, which form scattering volume 7.1 and 7.2 using their particular beam paths, are controlled simultaneously by microcomputer 9. In an alternative embodiment, scattered radiation measured values S11, S22 are obtained sequentially in time. For

this purpose, only one scattering volume 7.1, 7.2 is activated at a time, by controlling one pair of radiation transmitter 5.1 and radiation receiver 6.1 or radiation transmitter 5.2 and radiation receiver 6.2, whose beam paths form scattering volumes 7.1, 7.2, via microcomputer 9. The latter variation also offers the advantage that temporary interference, which may be caused by a moving insect, for example, may be differentiated from permanent interference, such as soiling. A further advantage of both embodiment variations is their comparatively high insensitivity to interfering external light. This will be explained on the basis of Figure 4. For example, radiation receiver 6.1 responds more strongly to external light if an external light source 12 is located in the solid angle range covered by the beam path of radiation receiver 6.1. Whether radiation receiver 6.1 is actually subject to interference from external light of an external light source 12 having beam path 40 may be determined easily by analyzing a measured signal of radiation receiver 6.1 when radiation transmitters 5.1, 5.2, 5.3 are not active. If a noticeable scattered radiation measured value S11 results during the measurement, this indicates interference by an external light source 12. Since, as illustrated in Figure 2 and Figure 4, radiation receiver 6.2 is situated offset by 180° in relation to radiation receiver 6.1 and fire detector 1, radiation receiver 6.2 is not impaired by external light source 12. This is used as a verification for radiation receiver 6.1 being interfered with by an external light source 12. In this case, however, fire detector 1 may still reliably detect smoke using scattering volume 7.2 and therefore fulfill its monitoring function. Without leaving the scope of the present invention, a fire detector 1 may, of course, also be expanded further. Thus, for example, it may operate using four different scattering volumes. In this case, the optical axes of the four radiation transmitters and radiation receivers now provided may each be situated rotated by approximately 90° from one another. This offers the additional

advantage that interfering external light from multiple directions may be suppressed.

In the following, it is assumed that radiation transmitter 5.3 and radiation receiver 6.3 are activated. Since scattering volume 7.3 formed by the beam paths of radiation transmitter 5.3 and radiation receiver 6.3 encloses a partial area of the surface of cover plate 4, radiation of radiation transmitter 5.3 is reflected on cover plate 4 and thus reaches radiation receiver 6.3, which provides a scattered radiation measured value S33. Even if there is no dirt on cover plate 4, a certain part of the radiation emitted by radiation transmitter 5.3 will be reflected by cover plate 4 to radiation receiver 6.3 as a function of the angle of incidence of the radiation on cover plate 4. The intensity of radiation transmitter 5.3 may expediently be set in such a way that the idle signal of scattered radiation measured value S33 thus arising assumes a predefinable value. In contrast, if there is dirt in the area of scattering volume 7.3 on cover plate 4, additional radiation is reflected by the dirt, so that scattered radiation measured value S33 measured at radiation receiver 6.3 assumes a higher value. In this way, soiling of cover plate 4 may be recognized reliably.

A change in the ambient temperature or aging of radiation transmitter 5.3 may result in the idle signal of scattered radiation measured value S33 falling below its starting value. By calculating ratios between the original and the current idle signal, a correction factor KF may be derived in order to compensate for the intensity change of radiation transmitter 5.3. This is expediently performed by applying a current corrected by correction factor KF to radiation transmitter 5.3. Furthermore, a defect in radiation transmitter 5.3, radiation receiver 6.3, or electronic circuit system 8 may be recognized in that scattered radiation measured value S33x assumes a no longer measurable value.

In order to guarantee a high operational reliability of the fire detector and reliably counteract gradual aging effects, a limiting value G is expediently predefined for scattered radiation measured value S33x. A value below this limiting value G is reported as a defect in fire detector 1.

In the following, it is assumed that radiation is emitted by radiation transmitter 5.1 and received by radiation receiver 6.2 or that radiation is emitted by radiation transmitter 5.2 and received by radiation receiver 6.1. As shown in Figure 5, further areas in which fire detector 1 responds sensitively to smoke particles or other objects during the measurement result as a function of the orientation of radiation transmitters 5.1, 5.2 and radiation receivers 6.1, 6.2. Thus, upon activation of and measurement using radiation transmitter 5.2 and radiation receiver 6.1, a fourth scattering volume 7.4 results. A scattered radiation measured value S12 may be determined using this scattering volume. Upon activation of and measurement using radiation transmitter 5.1 and radiation receiver 6.2, a fourth scattering volume 7.5 results. A scattered radiation measured value S21 may be determined using this scattering volume 7.5. If radiation transmitters 5.1 and 5.2 were not rotated by 180° in relation to one another, further scattering volumes 7.4 and 7.5 would be identical.

It is a further advantage of fire detector 1 according to the present invention that two further independent scattering volumes 7.4, 7.5 result through the rotation of radiation transmitters 5.1, 5.2 by 180°. The orientation of radiation transmitters 5.1, 5.2 and radiation receivers 6.1, 6.2 may, for example, be selected so that scattering volumes 7.4, 7.5 formed by them have a greater distance from cover plate 4 of fire detector 1 than scattering volumes 7.1 and 7.2. A smaller scattering angle thus results for scattering volumes 7.4, 7.5 than for scattering volumes 7.1 and 7.2. By comparing scattered radiation measured values S12 and S21

to scattered radiation measured values S11 and S22, the following additional information may advantageously be obtained. It may not only be recognized whether smoke is located in front of fire detector 1 at all. Rather, it may additionally be determined what type of smoke or fire it is. Since, if a smaller scattering angle is predefined, generally less radiation is scattered than in the case of a large scattering angle, scattered radiation measured values S12 and S21 will typically be smaller than scattered radiation measured values S11 and S22 if smoke is present in front of fire detector 1. The reduction of the intensity of the scattered radiation as a function of the scattering angle is strongly dependent on the type of smoke, in particular on the size of the smoke particles and the color of the smoke. Therefore, by calculating quotients S12/S11, S21/S11, S12/S22, and S21/S22, it may be determined what type of smoke it is. This information may be used for the purpose of better differentiating between dangerous fire smoke and rather harmless disturbance variables, such as water vapor or dust. Furthermore, it may be recognized whether an object is located in front of fire detector 1 and at what distance. For example, if scattered radiation measured values S11, S12, S12, and S21 are approximately of the same magnitude, then this indicates that an object is located in front of fire detector 1. If the object is located at a greater distance from fire detector 1, scattered radiation measured values S12 and S21 which are much larger than scattered radiation measured values S11 and S22 result.

In the following, it is assumed that radiation is emitted by radiation transmitter 5.3 and received by radiation receiver 6.2 or radiation is transmitted by radiation transmitter 5.3 and received by radiation receiver 6.1 or radiation is transmitted by radiation transmitter 5.2 and received by radiation receiver 6.3.

As shown in Figure 7, radiation transmitters 5.1, 5.2, 5.3 and radiation receivers 6.1, 6.2, 6.3 are mounted in holders 70, which

are preferably made of a material which does not reflect the radiation emitted by the radiation transmitters, in order to prevent interference through interference radiation. For example, they may be made of non-reflecting black-colored plastic material. For this purpose, recesses 71 are positioned in holders 70, which are oriented at an angle in relation to an external surface of holders 70. A predefinable emission angle and/or reception angle of radiation transmitters 5.1, 5.2, 5.3 and radiation receivers 6.1, 6.2, 6.3 mounted in holders 70 may thus be set. Furthermore, holders 70 are used for delimiting the solid angle in which a radiation transmitter 5.1, 5.2, 5.3 may emit radiation or from which a radiation receiver 6.1, 6.2, 6.3 may receive radiation. In this way, radiation transmitters 5.1, 5.2, 5.3 and radiation receivers 6.1, 6.2, 6.3 are shielded in such a way that radiation may leave radiation transmitters 5.1, 5.2, 5.3 only in a specific area around the optical axis of radiation transmitters 5.1, 5.2, 5.3 and radiation may reach radiation receivers 6.1, 6.2, 6.3 only in a specific area around the optical axis of radiation receivers 6.1, 6.2, 6.3. In this way, it is ensured that no radiation may reach radiation receivers 6.1, 6.2, 6.3 directly from radiation transmitters 5.1, 5.2, 5.3. Additional windows 72 may be introduced into these holders 70, through which radiation may be emitted by the radiation transmitters or received by the radiation receivers. In contrast to recesses 71, which are ~~necessary~~used for the scattered radiation measurement, i.e., from which radiation passes at a specific angle through cover plate 4 and leaves fire detector 1 and/or enters it, windows 72 are introduced laterally into holders 70, so that radiation exiting from these windows 72 and/or radiation entering these windows 72 propagates ~~essentially~~generally parallel to cover plate 4 and therefore does not leave the fire detector at all. The radiation exiting through these windows 72 and/or entering into these windows 72 is used for a function check of fire detector 1. In order that no radiation may reach radiation receiver 6.2 directly from radiation receiver

5.1 through windows 72 provided for the function check of fire detector 1 (and/or from radiation transmitter 5.2 to radiation receiver 6.1, or from radiation transmitter 5.1 to radiation receiver 6.1, and/or from radiation transmitter 5.2 to radiation receiver 6.2), screens 61.1, 61.2, 61.3, 61.4, 61.5 are situated within fire detector 1, which suppress direct propagation of radiation between radiation transmitter 5.1 and radiation receiver 6.2 (and/or between radiation transmitter 5.2 and radiation receiver 6.1, or from radiation transmitter 5.1 to radiation receiver 6.1, and/or from radiation transmitter 5.2 to radiation receiver 6.2). If radiation transmitter 5.1 is now controlled by microcomputer 9, for example, it may be measured using radiation receiver 6.3 whether radiation transmitter 5.1 still operates correctly. Radiation transmitter 5.2 and radiation receivers 6.2 and 6.3 may be checked analogously. In addition to the function check of radiation transmitters and radiation receivers explained above, the combinations of radiation transmitters and radiation receivers cited here and/or the scattering volumes formed by their beam paths may additionally also be used for a scattered radiation measurement.

~~Abstract of the Disclosure~~ABSTRACT

A fire detector ~~1~~ operating by the scattered radiation principle is described, having at least one radiation transmitter ~~5.1, 5.2, 5.3~~ and at least one radiation receiver ~~6.1, 6.2, 6.3,~~, whose beam paths form a scattering volume ~~7.1, 7.2, 7.3.~~. The fire detector ~~1~~ includes, in addition to at least one first radiation transmitter ~~5.1~~ and one first radiation receiver ~~6.1,~~, at least one second radiation transmitter ~~5.2~~ and one second radiation receiver ~~6.2,~~, whose beam paths form at least two spatially separated scattering volumes ~~7.1, 7.2.~~.

~~(Figure 2)~~